
Name of Organization: Wayne State University

Type of Organization: College or University

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Project Title: Reduction of Cadmium in CSO to the Detroit River

Project Category: Pollution Prevention and Reduction - BNS

Rank by Organization (if applicable): 0

Total Funding Requested (\$): 69,800 **Project Duration:** 1.5 Years

Abstract:

The database in the Industrial Wastewater Control Department of Detroit City has showed that the metal finishing plants in the Detroit area are the main contributors for wastewater with high concentration of cadmium and its compounds (topped the Level II list of BNS). The wastewater from plants enters combined sewer overflow (CSO). An excessive amount of wastewater is directly discharged into the Detroit River during wet weather. Over the past four years with the support from EPA, NSF, AESF Society, and local industries, the PI's research group has developed various plant models and model-based strategy for estimating, analyzing, and reducing wastewater from metal plant plants, which contains various toxic species including cadmium. In addition, the PI has worked with City of Detroit, SEMCOG, and USGS on an EPA project and successfully developed a general CSO model to predict the toxic concentrations and loading of various Levels I and II BNS pollutants discharged into the Detroit River. The PI is also a founder of Detroit River RAP P2 Action Team of U.S. Steering Committee. In this project, the PI will lead a sub- team to: (i) implement the plant cadmium model (CdPlant) and model-based strategy in 20 selected metal finishing plants in different regions, with the help from MDEQ, City of Detroit, (ii) conduct a deep analysis of the implementation results in the Detroit River basin, and (iii) use the CSO model to evaluate the impact of the model-based reduction of cadmium containing wastewater to the Detroit River. It is expected that cadmium-containing wastewater be reduced by 20% overall, and a complete analysis of cadmium-containing wastewater in the Detroit area be obtained to show the environmental and economic impacts. Furthermore, the project will generate the recommendation for optimal distributed wastewater treatment for long-term cadmium-containing CSO reduction and river water quality assurance.

Geographic Areas Affected by the Project**States:**

<input type="checkbox"/> Illinois	<input type="checkbox"/> New York
<input type="checkbox"/> Indiana	<input type="checkbox"/> Pennsylvania
<input checked="" type="checkbox"/> Michigan	<input type="checkbox"/> Wisconsin
<input type="checkbox"/> Minnesota	<input type="checkbox"/> Ohio

Lakes:

<input type="checkbox"/> Superior	<input checked="" type="checkbox"/> Erie
<input type="checkbox"/> Huron	<input type="checkbox"/> Ontario
<input type="checkbox"/> Michigan	<input type="checkbox"/> All Lakes

Geographic Initiatives:

<input type="checkbox"/> Greater Chicago	<input type="checkbox"/> NE Ohio	<input type="checkbox"/> NW Indiana	<input checked="" type="checkbox"/> SE Michigan	<input type="checkbox"/> Lake St. Clair
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Primary Affected Area of Concern: Detroit River, MI**Other Affected Areas of Concern:** Rouge River, MI***For Habitat Projects Only:*****Primary Affected Biodiversity Investment Area:****Other Affected Biodiversity Investment Areas:****Problem Statement:**

In the Detroit area, wastewater from different sources is mixed and normally sent to the Detroit Wastewater Treatment Plant before entering the Detroit River. During wet weather, however, a great amount of excessive wastewater is directly discharged into the Detroit River through combined sewer overflow (CSO). Cadmium, a Level II BNS targeted substance, is one of the major toxic pollutants contained in the wastewater generated by a large number of metal finishing plants in the Detroit area. To drastically reduce this and other toxic pollutants in the River, the source reduction in this industry is a key. It becomes an urgent need to provide a complete picture of their discharge levels in the Detroit River, and to identify a pollution prevention approach for cadmium reduction in plan. This is certainly not a trivial task. We need a scientific, systematic, and effective methodology for (i) examining all major sources, (ii) implementing an effective source reduction methodology in plants, (iii) evaluating plant discharge distributions through CSO to the River, and (iv) identifying long-term, cost-effective, localized, optimal wastewater pretreatment strategies. This methodology must be implemented at the both plant and CSO-river levels. Hitherto, such a methodology has not been available.

Proposed Work Outcome:

This proposal centers on the development and implementation of a novel methodology for reducing cadmium-containing wastewater into the Detroit River. During the past four years with the support from EPA, National Science Foundation, MDEQ, American Electroplaters and Surface Finishers Society, and local industries, the PI's group has developed a unique methodology for a simultaneous realization of optimal production and pollution prevention in metal finishing plants. Various first principles-based plant models are developed for characterizing all major operations, such as soak cleaning, electrocleaning, acid cleaning, rinsing, and various plating. A model-based P2 strategy is also developed to determine the optimal setting of chemicals, rinse water flow rates, and parts processing time. The implementation in a number of plating lines has shown that pollutants including cadmium, wastewater, and sludge can be reduced by 25%, 28%, and 15%, respectively, with extremely low capital investment. This strategy has lead to the development of six P3 (profitable P2) technologies for comprehensive waste reduction. At the same time, the plating quality can be even improved by 10%.

In addition, the PI and Prof. Ralph Kummier (leader of U.S.-Canada Detroit River RAP Steering Committee) have worked with SEMCOG, City of Detroit, USGS, and MDEQ on an EPA project over the past four years. As the key researcher, the PI has developed a first-principles-based, simplified CSO model to predict a list of 51 toxic pollutants discharged through CSO to the Detroit River. The model has been validated using historical data (1979-90) and USGS 1994-95 CSO sampling database. A model-based prediction program has been loaded into the SEMCOG GIS system. Extensive simulations and comprehensive studies of the model predictions have demonstrated that the model predictability is far better than any existing CSO models.

With the success in those two projects, the PI intends to: (i) integrate the plant cadmium model and CSO model, (ii) to implement the integrated model in plants, (iii) to conduct a comprehensive evaluation and reduction of cadmium discharge using the CSO model, and (iv) to develop a cost-effective strategy for a long-term cadmium reduction in the Detroit area. Since June 1999, the PI, as one of the two founders of the Detroit River RAP P2 Team working under the US Steering Committee, is leading a sub-team to launch a program - maximum wastewater reduction from metal finishing plants to the Detroit River. This effort is being supported by City of Detroit, MDEQ - Environ. Assist. Division, EPA Strategic Goal Program, and local stakeholders. In this proposal, the major tasks are briefly described below.

Task 1. To integrate the plant-wide cadmium reduction (CdPlant) model and the CSO prediction model. The CdPlant model will be applied to 20 selected major metal finishing plants in different regions in the Detroit River basin. The outputs of the model will be the inputs to the CSO model based on plant locations. Currently, the two computer models have been already in the PI's research lab. The SEMCOG GIS system will be used to locate the plants for precise application of the CSO model. It will need three months to accomplish this task.

Task 2. To implement cadmium wastewater reduction strategy in the selected major metal finishing plants. In this implementation, the PI's Detroit River RAP P2 sub-team will firstly organize a workshop, with the assistance from MDEQ EAD/P2 Section, AESF Detroit Section and City of Detroit DWSD. This workshop will (i) help plant managers and engineers understand the model-based cadmium reduction strategy, (ii) demonstrate computer analysis for several case studies, (iii) help plants develop implementation plans, (iv) conduct an initial analysis on economic and environmental impacts, and (v) show the environmental and economic impacts on the Detroit River. After workshop, the PI's team will work with the plants to implement their plans in production lines. Computer models will be delivered to plants for their use, with an agreement on intellectual property protection. The model parameters may be re-adjusted in individual plants. At the end of this period, a report from each plant will be generated. This report will include the information of the discharge in cadmium-containing wastewater before and after the implementation of the model-based strategy. A summary report will be submitted to the Detroit River RAP U.S. Steering Committee. It will need six months to accomplish this task.

Task 3. To run the CSO model developed by the PI's team. The first phase of the model simulation is to examine the cadmium discharge based on the plant database for different regions in the Detroit area, such as Conner Creek, Fischer, Rose Park and Schroeder. In the second phase, more specific simulation will be conducted to examine specific regions where more severe cadmium discharge occurs. In the third phase, simulations of the plant discharge after implementing the cadmium reduction strategy will be conducted. The whole CSO simulation will provide a complete comparison of cadmium-containing wastewater discharge into the Detroit River. This result will be loaded into the SEMCOG GIS system for further analysis. This task requires six months to accomplish.

Task 4. To develop a long-term cadmium wastewater reduction strategy for the Detroit River basin. The main effort will be on the identification of distributed wastewater pretreatment strategy. Based on the PI's investigation, nearly all major metal finishing plants have their own wastewater treatment facilities. For the protection of the water quality of Detroit River, the cadmium control at the different levels in different regions must be implemented, according to EPA regulations. This long-term strategy is essentially the design of distributed wastewater treatment systems, but implemented in plants. An economic justification will be generated for each participating plant where the capacity of treatment facility should be evaluated and readjusted, if necessary. This task will need three months to finish.

At the end of the project, the plants implementing the cadmium reduction strategy are expected to have 20% of reduction in their wastewater streams. The CSO loading of cadmium into the Detroit River will be also correspondingly reduced. A complete analysis report on the cadmium-containing wastewater distribution in the Detroit River will be generated. This report will also provide recommendations on distributed wastewater treatment for long-term reduction of cadmium in the Detroit River.

Project Milestones:**Dates:**

Development of an integrated model	07/2000
Organize a workshop	10/2000
Implementation of plant Cd reduction plan	11/2000
CSO model simulation and analysis	04/2001
CSO Cd reduction strategy development	07/2001
Distributed wastewater treatment plan	10/2001
Project End	12/2001
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☒ Project Addresses Environmental Justice

If So, Description of How:

In this project, a number of people in the Detroit River RAP P2 Team will participate in various activities. This group of people, including minorities from academia, City of Detroit, various industries and local governments will work together to accomplish the tasks defined for this 1.5 year project.

☒ Project Addresses Education/Outreach

If So, Description of How:

Managers, environmental and process engineers of the selected metal finishing plants as well as local governments will be educated in a workshop which is to be organized by the PI. This workshop will (i) help them understand the model-based cadmium reduction strategy, (ii) demonstrate computer analysis for several case studies, (iii) help plants develop implementation plans, and (iv) conduct an initial analysis of economic and environmental impacts on the Detroit River. After workshop, the PI will work with the plants and local governments to implement their plans in production lines and CSO management.

This project will also support one Ph.D. student to conduct the proposed research in the PI's group. The student will also assist the PI for the workshop. This will eventually help the local government/industry generate a highly qualified researcher for environmental planning and wastewater reduction and management, and river water quality protection. Wayne State University is the largest non-HBCU minority universities in the U.S. The PI will make every effort to identify a minority student for this project.

Project Budget:

	Federal Share Requested (\$)	Applicant's Share (\$)
Personnel:	34,000	4,000
Fringe:	11,988	1,400
Travel:	1,000	0
Equipment:	0	0
Supplies:	1,000	0
Contracts:	0	0
Construction:	0	0
Other:	0	0
Total Direct Costs:	47,988	5,400
Indirect Costs:	21,812	0
Total:	69,800	5,400
Projected Income:	0	0

Funding by Other Organizations (Names, Amounts, Description of Commitments):

Michigan Department of Environmental Quality, \$80,000, 5/00-4/01. A meeting was made with the P2 Section of the Environmental Assistance Division of MDEQ for the funding of a P3 demonstration project. It is targeted to achieve very significant reduction of wastewater, chemical, and sludge in electroplating plants. It is highly possible to have this fund from the State.

American Electroplaters and Surface Finishers Society, \$100,000, 4/96-3/01. The last year's task is to develop a new P3 technology -- reversed drag-out technology for sludge reduction.

Description of Collaboration/Community Based Support:

The PI is a founder of the Detroit River RAP P2 Team under the Detroit River RAP U.S. Steering Committee. This team is a cross-cutting action team including people from the City of Detroit, local governments, industries, and Wayne State University. This team works with five Environmental Action Teams (CSO/Point Source Pollution Action Team, Contaminated Sediments Action Team, Non-Point Source Pollution Action Team, Habitat Action Team, and Land Use Action Team). In the P2 Team, the PI is leading a sub-team for the wastewater reduction from the metal finishing industries to the River, but has no funds available. This team has been closely working with the CSO/Point Source Pollution Action team.

In addition, the PI will continuously collaborate with the AESF Society and the Detroit Section of AESF, and SEMCOG. The PI has a very close relationship with the local metal finishing industry, and SEMCOG. Strong technical assistance from these partners will be continued in the project period.